Journal of the Royal Society of Arts

NO. 4974 FRIDAY, 30TH MARCH, 1956 VOL. CIV

FORTHCOMING MEETINGS

THURSDAY, 12TH APRIL, at 5.15 p.m. COMMONWEALTH SECTION. THOMAS HOLLAND MEMORIAL LECTURE. '*The Work of the Colonial Development Corporation*', by H. Nutcombe Hume, C.B.E., M.C., Deputy Chairman, Colonial Development Corporation. The Right Honble. Lord Milverton, G.C.M.G., will preside. (Tea will be served from 4.30 p.m.)

MONDAY, 16TH APRIL, at 6 p.m. The first of three CANTOR LECTURES, illustrated with lantern slides, on '*Modern Welding*', by H. G. Taylor, D.Sc., M.I.E.E., F.Inst.P., Director, British Welding Research Association. (See syllabus below.)

WEDNESDAY, 18TH APRIL, at 2.30 p.m. '*T. H. Huxley and Technical Education*', by Cyril Bibby, M.A., M.Sc., Ph.D. R. W. Holland, O.B.E., M.A., M.Sc., LL.D., Chairman of the Council of the Society, will preside.

MONDAY, 23RD APRIL, at 6 p.m. The second of three CANTOR LECTURES on '*Modern Welding*', by Dr. H. G. Taylor.

WEDNESDAY, 25TH APRIL, at 2.30 p.m. '*Beauty in Danger—the Rural Scene*', by Sir George Pepler, C.B., Past-President, Town Planning Institute. Dame Evelyn Sharp, D.B.E., Permanent Secretary, Ministry of Housing and Local Government, will preside.

THURSDAY, 26TH APRIL, at 5.15 p.m. COMMONWEALTH SECTION. '*The Snowy Mountains Scheme*', by C. M. Gray, O.B.E., E.D., M.Sc., A.M.I.E.(Aust.), Senior Representative, Department of National Development, Commonwealth of Australia. J. F. Herbert, B.E., M.I.E.E., M.I.E.(Aust.), of the English Electric Co., Ltd., will preside. (The paper will be illustrated. Tea will be served from 4.30 p.m.)

MONDAY, 30TH APRIL, at 6 p.m. The last of three CANTOR LECTURES on '*Modern Welding*', by Dr. H. G. Taylor.

WEDNESDAY, 2ND MAY, at 2.30 p.m. '*Beauty in Danger—the Urban Scene*', by Sir Hugh Casson, M.A., F.R.I.B.A., R.D.I., Professor of Interior Design, Royal College of Art. The Right Honble. The Earl of Euston, Deputy Chairman, Society for the Protection of Ancient Buildings, will preside.

Fellows are entitled to attend any of the Society's meetings without tickets (except where otherwise stated), and may also bring two guests. When they cannot accompany their guests, Fellows may give them special passes, books of which can be obtained on application to the Secretary.

SYLLABUS OF CANTOR LECTURES ON 'MODERN WELDING'

LECTURE 1. *Monday, 16th April.* Metal arc welding; electrode coatings; methods of manufacture of electrodes; automatic processes; use of shielding gases; consumable and non-consumable electrodes; growth of industry; economy of weight.

LECTURE 2. *Monday, 23rd April.* Welded joints; properties of welds and weld metal; fatigue of welds; methods of testing; application of welding to shipbuilding, bridges, cranes, structures, steam and nuclear power plant, oil industry, etc.

LECTURE 3. *Monday, 30th April.* Resistance welding; history and development; various processes and types of machines; testing and inspection; economics; applications including gas turbines and aircraft; future trends.

THOMAS GRAY MEMORIAL TRUST

PRIZE FOR A DEED OF PROFESSIONAL MERIT

In recognition of the remarkable skill which is so constantly displayed at sea, the Council of the Royal Society of Arts offered last year under the Thomas Gray Memorial Trust an award of £50 for a deed of outstanding professional merit by a member of the British Merchant Navy. This award has been made to Mr. Charles S. Owston, of North Shields, now Chief Officer of the M.S. *Heldia*, for the following operation at sea:

At about 5.30 a.m. on 30th November, 1954, in the entrance to St. George's Channel, an S.O.S. was received by M.S. *Liparus* from M.S. *Tresillian* saying that she was listing heavily to port and requesting ships to stand by. Course was altered and emergency rescue preparations put in hand. The wind was westerly force 8–9, and seas high with a heavy swell and severe squalls.

As the *Liparus* approached the distressed vessel radio contact was maintained and the master of the *Tresillian* asked for oil to be spread on the water. Radio contact ceased before 7 a.m., when the *Liparus* was about five miles away. The *Tresillian* was sighted on the radar screen and oil was spread. Shortly afterwards the *Tresillian* sank.

When the *Liparus* reached the vicinity lights were observed on the water's surface and a lifeboat and a raft, both manned, were seen. Owing to the rough seas the utmost caution was necessary to avoid injury to the survivors and it was necessary to await a lull in the heavy squalls before a lifeboat could be launched. At 9.03 a temporary lull made it possible for a lifeboat to be launched under the command of Chief Officer C. S. Owston and manned by a volunteer crew.

In appalling conditions the lifeboat picked up all survivors who could be sighted in the water and then made for the *Tresillian's* lifeboat. An attempt was made to take it in tow but this proved impracticable; the only hope was to get the occupants into the *Liparus* boat, but conditions were such that no direct transfer was possible. The survivors had to jump into the water and all were picked up by the *Liparus* boat, which made its way back to the falls amidships on *Liparus*. Attempts were made to hook on the falls, but, with the seas pouring over the deck of the *Liparus*, the foredeck offered the best chance of getting the survivors, who were past helping themselves, aboard and the master accordingly ordered the boat forward. Unfortunately at that moment her engine failed and this, coupled with the oil which made the handling of ropes and survivors extremely difficult, added greatly to the hazards of the operation of getting the occupants of the boat aboard. The lifeboat sank just before the last of the men remaining alive were transferred. The Chief Officer

was one of these and, by this time exhausted and quite unable to help himself, was only rescued by the strenuous efforts of a pumpman aboard the *Liparus*.

Thirteen survivors were taken aboard the *Liparus*, one of whom died shortly afterwards.

During the whole of this operation visibility was at times almost nil in the squalls and the *Liparus* was out of sight of her lifeboat for two and three minutes at a time because of the swell and poor visibility. Only from the crests of the waves could any survivors be sighted and the search for them demanded the greatest skill and courage, but Chief Officer Owston manœuvred his boat with consummate skill and displayed seamanship of the highest order.

The Council have decided to offer a further prize this year for a Deed of Professional Merit by a member of the British Merchant Navy. The prize will be the Society's Silver Medal.

The period to be covered by the offer will be the year ending 30th September, 1956, and deeds of a character worthy to be considered for the award may be brought to the notice of the Council by any person not later than 31st December, 1956. They will not, however, be considered by the judges unless they have been endorsed by a recognized authority or responsible person able to testify to the deed to be adjudged.

The Council reserves the right to withhold the above award at its discretion.

EXHIBITION OF EUROPEAN MEDALS, 1930–1955

The Society's Exhibition of European Medals, 1930–1955, which, as previously announced in the *Journal*, has been touring the United Kingdom, is now on view at the National Museum of Wales, Cardiff, where it will remain until 21st April. This is the last showing of the Exhibition planned to take place before it is dismantled.

Fellows will remember that the Exhibition, which was originally held at the Society's House last June, contains medals from 12 European countries, some coins, and a special exhibit of Coronation Medals provided by the Royal Mint.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 12th March, 1956. Present: Dr. R. W. Holland (in the Chair); Mrs. Mary Adams; Dr. W. Greenhouse Allt; Mr. F. H. Andrews; Sir Alfred Bossom; Mr. Robin Darwin; Mr. P. A. Le Neve Foster; Mr. John Gloag; Mr. Milner Gray; The Earl of Halsbury; Lord Latham; Mr. F. A. Mercer; Mr. O. P. Milne; Lord Nathan; Sir William Ogg; The Earl of Radnor; Mr. A. R. N. Roberts; Sir Harold Saunders; Sir Selwyn Selwyn-Clarke; Sir John Simonsen; Professor Dudley Stamp; Sir Stephen Tallents and Sir Griffith Williams; with Mr. K. W. Luckhurst (Secretary), Mr. R. V. C. Cleveland-Stevens (Deputy Secretary) and Mr. David Lea (Assistant Secretary)

ELECTIONS

The following candidates were duly elected Fellows of the Society:

Adamson, Colonel Keith Frazee, B.M.E., Warrenton, Virginia, U.S.A.
Auger, Professor Pierre V., Paris, France.
Aylett, David, A.R.I.B.A., Aylesbury, Bucks.

Clarke, Leslie, Ipswich, Suffolk.
Clifford-Wing, Hugh Vincent, London.
Dalby, Clarence Reginald, Leicester.
Downs, Leslie Hall, C.B.E., M.A., M.I.Mech.E., Driffield, Yorks.
Fearn, Stanley Walter, A.R.I.B.A., F.N.Z.I.A., Wellington, New Zealand.
Fielding, Robert, Rutledge, Pennsylvania, U.S.A.
Ford, Frank Roy, Bromley, Kent.
Foy, Charles Frederic, Watford, Herts.
Frith, John William, Kingston-on-Thames, Surrey.
Gan, Tech Yeow, Kuala Lumpur, Malaya.
Grady, Professor James Henry, B.Arch., Atlanta, Georgia, U.S.A.
Kwan, Yim Chor, B.A., Hong Kong.
Millington, Roy, Sheffield, Yorks.
Peeps, Professor John Calder, B.Arch., A.R.I.B.A., M.R.A.I.C., Vancouver, British Columbia, Canada.
Perry, Stuart, LL.B., A.L.A., J.P., Wellington, New Zealand.
Powdrill, Kenneth Stanley James, A.T.D., Wolverhampton, Staffs.
Talley, Brigadier General Benjamin B., D.S.C., Manqum, Oklahoma, U.S.A.
Tennyson-d'Eyncourt, Sir Gervais, Bt., Burley, Hants.
Wright, Bert, Warrington, Lancs.
Wright, The Rev. Ronald W. V. Selby, T.D., M.A., F.S.A.(Scot.), Edinburgh.

The following were elected Associate Members as winners of Industrial Art Bursaries in 1955:

Collins, Anthony Bryn, Kidderminster, Worcs.
Collins, Paul Joseph, London.
Lane, Robert John, Birmingham.
Sadler, Kenneth George, Oldbury, Worcs.
Thomas, David Arthur, Hampton Hill, Middx.
Tuson, Edward Herbert Robert, Chilworth, Surrey.
Walsh, Miss Freda Anna, Cheadle Hulme, Cheshire.
White, Miss Angela Carol, Rickmansworth, Herts.

The following was admitted as an Institution in Union under Bye-Law 66:

The British Optical Association, London.

R.D.I. JOINT COMMITTEE

The following were appointed to represent the Council for the forthcoming year, namely: Sir Ernest Goodale (Chairman); Mrs. Mary Adams; Mr. F. H. Andrews; Sir Alfred Bossom; Mr. John Gloag and Mr. F. A. Mercer.

ALBERT MEDAL

Further consideration was given to the award of the Albert Medal for 1956.

CURATOR-LIBRARIAN

The appointment of Mr. D. G. C. Allan, who had been acting as temporary Curator-Librarian since last October, was made permanent.

EXAMINATIONS

Reported that the number of entries received for the Easter Series of Examinations was 28,625.

OTHER BUSINESS

A quantity of financial and other business was transacted.

A NEW APPROACH TO FURNITURE DESIGN

A symposium of three papers by

M. J. MERRICK, B.Sc. (Eng.), G.I.Mech.E., Head of the Research Department of the Furniture Development Council; T. KOTAS, B.Sc. (Eng.), G.I.Mech.E., and ROBIN DAY, A.R.C.A., F.S.I.A., read to the Society on Wednesday, 11th January, 1956, with Sir Herman Lebus, C.B.E., J.P., Chairman and Managing Director of Messrs. Harris Lebus, Ltd., in the Chair

THE CHAIRMAN: I have accepted with very great pleasure the invitation by the Royal Society of Arts to take the chair at this meeting.

The Symposium to which we are to listen will consider the application of research to furniture, and also how much such application may alter its character and its design. These considerations you will agree, I am sure, are of particular importance to the furniture industry. They are, I believe, the main arteries through which flows its life blood, the life blood of information and of enlightenment. Without them the industry would not, and indeed will not progress at all.

The Royal Society of Arts, whose aims are the advancement and the development and the application of every department of science in connection with Arts, Manufactures and Commerce is a very appropriate body to call together a meeting such as this. In this very hall before the war the public made its acquaintance with the telephone, the flying machine and with wireless and other wonders, and we should recall that the Society numbered amongst its earliest members Thomas Chippendale and Robert Adam—those masters of the craft of furniture. Robert Adam in fact helped to design the building in which we meet to-day, but this, I believe, is the first time that the application of research to the furniture industry has been studied at one of the Society's meetings.

If we are to lead in the world of furniture, as in the days of those great masters, we cannot afford to underestimate the value of research and its potential effect on the construction and character of the industry's products and indeed on materials that it uses. For it is the job of research to seek causes, reasons and ways and means. Now whilst research has, for many years, been the trusted ally of one or two firms in the industry co-operative research is something of a post-war development. Sir Stafford Cripps, when he was President of the Board of Trade, set up a working party in 1945 to examine the organization of the furniture industry. I had the honour to be one of its members, and one of its recommendations was that a Technical Research Association should be set up to work upon the industry's research problems and to spread information concerning research carried out at home and abroad. The Furniture Development Council was accordingly established under the Industrial Organization and Development Act of 1947, and thereafter a Research Department was set up on a disused airfield at Redhill. This Research Department has recently moved to North London, and there it occupies premises which also house the technical information services. Research should be a continuous process. It brings its discoveries, and as these are understood and absorbed new problems arise, new problems which themselves call for new research to provide new solutions.

It will interest you to know how greatly the Furniture Development Council understands, preaches and practises the inter-relationship of research with technical information, with work study, with methods study, planning, costing and other essential industrial and commercial tools. This conception of inter-relationship is of very great benefit to the industry.

The first paper is by Mr. M. J. Merrick, who is Head of the Research Department of the Furniture Development Council. He will tell us something of the present work of the Research Department and laboratories and of other work which will be introduced and undertaken in the future. There is a large research programme before the Department which Mr. Merrick guides, and I think he is very busy. The second paper is by Mr. T. Kotas, who is one of Mr. Merrick's staff. He will describe some of the work which he has been carrying out concerning the behaviour of cabinet furniture under various conditions of loading life. The object is to ascertain if structures can be designed which effect economies in the use of materials but which are entirely adequate in strength and stability. Many of Mr. Kotas' conclusions will perhaps be known to some of you, but they will not have been presented in a simple and practical way, as we believe they will be presented to-day, for application to real problems of design and construction. The third paper is by Mr. Robin Day, who is well known to you as one of the foremost industrial designers of furniture. A few years ago, in association with Mr. Clive Latimer, he won an international competition for furniture design organized by the Museum of Industrial Act in New York. Mr. Day's paper will give his impressions of the way in which results of Mr. Kotas' work will have an effect on design of the future. I am very sorry to say that Mr. Day has a bad throat to-day. Mr. Merrick has therefore kindly agreed to read his paper for him.

I should emphasize that these brief papers are each considering only one small aspect of the work which is being carried out by the Furniture Development Council and their Research Department. The Department has made a really good contribution to providing a scientific foundation to our knowledge, and I am sure that the papers to which we are to listen will build on that foundation which has so well and truly already been laid.

The following papers, which were illustrated with lantern slides, were then read:

THE PAPERS

I. RESEARCH IN THE FURNITURE INDUSTRY

by

M. J. MERRICK, B.Sc. (Eng.), G.I.Mech.E.

Before we consider research in the furniture manufacturing industry, it is vital that we should be quite clear on what we mean by research. It is probable that much of the difficulty in applying research results, and scientific methods in general, to the problems arising in this and other craft industries, is due to some extent to confusion regarding the nature of research and, in particular, where research ends and development and application begin. The *Concise Oxford Dictionary* defines research as 'endeavour to discover facts by scientific study of a subject; course of critical investigation'. There are two points to be noted. Firstly, research is intended to discover facts. Secondly, the facts are discovered by scientific study; that is, by systematic and accurate methods, and not by trial and error. The application of the new knowledge found by research is a separate, and often more complex problem to that of carrying out the

research, and this meeting to-day will, I hope, be regarded as a step forward in the application of one part of our research work in the furniture industry.

Once we understand what research means, it is apparent that the discovery of new facts about materials, methods of construction and other subjects is useful. There are, of course, difficulties in carrying out research in the furniture industry which do not usually exist elsewhere. Firstly, we are dealing largely with timber, a natural material varying in its properties, and not consistent or repeatable like steel, plastics or similar manufacturing materials. In this and similar respects the work carried out by the Forest Products Research Laboratory, and other research organizations at home and abroad, is of great help to us in our own research. Secondly, there are the combined difficulties of lack of information on the behaviour and durability of furniture in normal use, and the lack of a clearly defined function for most articles. A carpet sweeper, for instance, has a definite single function, and any fault in that function is readily found and communicated to the maker. In furniture, however, which usually has to fulfil a number of functions at once, this precise feedback of information is much more difficult to obtain.

In spite of these difficulties, however, much useful work can be and has been done. For convenience, we may divide the present work into two main categories. Firstly, there is the basic research work, which is of a fairly fundamental long-term nature. The results of such work, the first of which we shall hear later to-day from Mr. Kotas, are intended to be of a generally applicable nature, concerned usually with principles and not details. The results of such work can be of far-reaching consequence and considerable economic importance. Secondly, there is the applied research, usually of a more short-term nature and concerned with the more transient problems of the industry. There is, of course, no clean cut division, and one of the main problems in applied research is to balance the time and money spent on a particular project against the potential value of the results.

Basic research work in other industries is usually concerned with studying a subject so that some commodity may be made more simply and hence more cheaply. It is dangerous, however, glibly to compare other industries with the furniture industry, and to assume that because one industry does a particular type of research, our industry should concentrate on a similar line. In order to get the most out of basic research, it would seem to be necessary to study the comparative cost picture in the industry concerned. It is here that we can see the potential winners. In other industries the cost of materials is often small compared with the cost of the final article, and research, therefore, is usually concentrated on manufacturing processes, since these normally constitute the bulk of the expenditure. In the furniture industry, however, just over half the cost of the finished article is taken up by raw materials; just under half is taken up by labour, overheads and the rest. Board of Trade figures for 1948 to 1951 show that not only are the material costs large, but seem to be slowly increasing. Those facts are confirmed for the years subsequent to 1951 by figures obtained in the Furniture Development Council Comparative Cost Scheme.

In view of this state of affairs the overall policy of the basic research work in the Department is to find new knowledge which will lead to the more efficient use of our expensive raw materials. We spend a lot of money on these, and even an overall saving of one per cent would be most significant economically as will be seen from Figure 1, which shows possible savings of three of the most important raw materials, namely timber, which includes plywood and similar products, finishing materials, and upholstering materials, excluding covers. Covers themselves, of course, account for a considerable sum each year, but I am afraid our resources are not yet large enough to include them in our programme. The three items mentioned in Figure 1, together with applied work, are, nevertheless, covered by our present programme.

Material	*Estimated expenditure per annum*	*Saving per annum*
Timber and plywood	£25m.	£250,000
Finishes	5m.	50,000
Upholstery (excluding covers) ...	5m.	50,000
	£35m.	£350,000

FIGURE 1. *Possible savings in materials based on a reduction of one per cent*

Dealing with timber, our most important material, there has been so far a theoretical and experimental study of the structure of carcase furniture, such as wardrobes, to lead to a better understanding of the function of the various parts of such an article in contributing to the stiffness of the article as a whole. With such knowledge, it should be possible for us to use our timber in a more efficient manner. Since it is this aspect of the work with which Mr. Kotas will be dealing, I will say no more at the moment, except to point out that it is likely that this work will extend to other furniture structures in the future.

We also plan to investigate the relative importance of all the various factors which may go to affect the strength of glued joints, particularly the dowel joint and the mortise and tenon joint. One may ask what this has to do with economy of materials, but if one appreciates that the size of a member is often decided by the size of the joint which has to be made at the end, the connection is apparent.

On the finishing side we have also two main branches. Firstly, we are trying to develop some simple tests, and other aids to buying, for finishes. At present there is no objective guide at all to the probable behaviour of a finish in service nor even how it compares with a similar finish. The furniture manufacturer is entirely dependent on the advice and good name of the supplier, and although this system may work up to a point, it is one which obviously can be improved. Secondly, we are making an investigation of the spraying process. It is

rather surprising that a widespread industrial process such as spraying things on to other things should have attracted so little attention on the research side. Some work has, of course, been done, but it seems to be less than one would expect. The aim of this work is to cut down the waste of lacquer. It is apparent when spraying articles of furniture that not all of the lacquer is deposited; some of it is lost through the extractor fans of the booth. At the moment we do not even know how much is lost, but we are trying to find out, and will then endeavour to discover means of cutting down that loss.

In the field of upholstery the policy is again to study the design of upholstered articles; to find out more about the contribution of the various parts, the springs, the stuffing, and so forth, to the properties of the final product, and so obtain information which will enable us to use our raw materials more efficiently. Upholstery is a rather more complex subject than the others, since it is so difficult to define what is wanted or indeed, to define objectively a particular seat at all. As a start in measuring the properties of seats, therefore, we are developing a device which will measure the pressure distribution between a seat and the person sitting on it. With such basic information we will then be able to measure the results of any changes we may make in the upholstering methods.

In addition to the basic research the main lines of which are outlined above, we are also doing work of a more applied nature on a variety of subjects. The most interesting of these is probably the use of chipboard in furniture. This investigation is intended to enable the industry to define the properties of chipboard which are desirable for use in furniture, and not only to define those properties but, if possible, to set desirable limits to them as well. The work is associated with the basic work on structures; in this case, however, the use of an alternative material in effecting economics is involved, instead of using a traditional material more economically.

Another set of new materials we have been studying are the PVA adhesives. These have many properties which make them very attractive to the furniture manufacturer but, like all new materials, they require to be understood before they can be used to the best advantage. Another interesting investigation of an applied nature is the problem of the darkening of clear finished furniture under the action of light. This darkening has, in the past, often been blamed on to the lacquer, but in many cases it has been shown to be due to an actual darkening of the wood itself. These are three examples of projects of a more applied nature that we have been, and still are, undertaking. In addition to these more major investigations we have, from time to time, carried out a number of short tests of an *ad hoc* nature on a variety of subjects ranging from the strength of coffee table legs to a new method of fixing upholstery webbing.

This, then, is a general picture of the various aspects of our present work. For the rest of this symposium one aspect only will be considered, namely the study of the rigidity of carcase furniture. Mr. Kotas will describe the actual research work and explain the principles of construction which have been evolved; Mr. Robin Day will then describe some possible effects on future design. Apart from the future, however, there are great potentialities in applying the principles

to articles of what are usually known as orthodox construction, that is, to the normal mass-production type of carcase which is produced in such large quantities to-day. To conclude, I would like to describe a problem we have already investigated.

This was a case where a wardrobe, made and sold in large quantities and at a very competitive price, was already thought to use material with the maximum effectiveness, the manufacturer concerned being well aware of the details of the cost breakdown of his product. A split carcase was made from what are usually known as 'biscuits'. The doors were hung on the ends with simple shaped corner braces top and bottom, and there was a 'dummy' down the middle of the open face. The two halves of the top were joined by means of a simple tie rail back and front; the bottom had a tie rail at the back only. The bottom was housed into the stiles of the 'dummy' and was secured by two screws to the bottom rail of the 'dummy'. The packing pieces and shaped plinths were then screwed to the bottom front rail. The problem was to stiffen the wardrobe without using any extra material, or making production too complicated. Mr. Kotas will tell you later how this was done by applying the results of his work.

Many would say that the alterations are obvious and that if it was required to make the article more rigid, it would only require common sense to do what has been done in this case; that research was unnecessary to effect such changes. This view, however, gives rise to two points. Firstly, there is a very considerable difference between scientific and intuitive methods based in part on experience, particularly where a change in a mass production design is involved. Secondly, although some of those faced with the problem might get part of the answer, I hope that Mr. Kotas' work will help all the people to get all of the answer in similar circumstances in the future.

One great difficulty remains, which is by no means confined to that part of our research we are concerned with in these papers, and that is ensuring that research results are understood, and used, by those in the factories. The great criterion of research is 'what has it changed?' Unless the results of industrial research change something already existing or create something new they have not realized their value. This may be the fault of the research but it is more likely to be due to some fault in the bridge between the laboratory and the factory floor. This symposium is an attempt to widen that bridge; to bring the research worker, the furniture designer, and the furniture manufacturer into closer contact, and so make progress toward a more mutual understanding of one another's function in the design and manufacture of furniture.

The Royal Society of Arts, during its long history, has always endeavoured to bring together the engineer and the artist, the scientist and the designer; endeavoured to weld together the many varying aspects of creative thought which go together to make an industrial product. Nowhere, therefore, could be more appropriate for this symposium to-day than in this hall, and with Sir Herman Lebus in the chair. I would like to conclude by expressing our gratitude and appreciation to the Society for the opportunity we have been given to present our papers to-day.

II. APPLICATION OF RESEARCH TO FURNITURE CONSTRUCTION

by

T. KOTAS, B.Sc. (Eng.), G.I.Mech.E.

In the first place I should like to modify the impression, which the title of this paper may suggest, that we are going to attempt to discuss the whole field of furniture design. The subject is far too wide to be dealt with in such a short time as we have available. Since, beside a general discussion of the problem, we also intend to give some actual findings of our research work, we will have to confine ourselves to cabinet furniture, because this is the only type of furniture considered so far in this particular branch of our work. This fundamental work will be extended eventually to other types of furniture.

Our primary object was to study the behaviour of cabinet furniture under various probable conditions of loading with a view to using this knowledge in reducing the material content and thus making furniture at a lower cost. With this object in mind, let us consider what are the factors limiting an arbitrary reduction in material content. After all, it is quite obvious that in most cases we cannot simply reduce the cross-section of every component of the cabinet by, say, fifty per cent without affecting its serviceability. It does not take an engineer to appreciate the fact that an arbitrary reduction in material content of this kind might reduce the strength of some components. Joints are the most vulnerable of these because they are usually situated in the parts of the cabinet which are subjected to highest stresses. Although the question of the strength of joints is quite important, I shall not deal with it in this talk because the problems involved are of entirely different nature and consequently are investigated separately.

Another trouble we might find on reducing the material content arbitrarily, is that the bearing surfaces such as shelves and tops of sideboards are no longer able to sustain their loads without excessive deflection. Also, an arbitrary reduction in panel thickness of, say, wardrobe ends would result in the lowering of their resistance to local pressure. All these troubles could be put under one heading of the lowering of local rigidity.

The last type of trouble arising from an arbitrary reduction of material content would come from the overall distortion. We might find that a cabinet distorts as a whole due to causes such as an uneven floor or unsymmetrical loading. The overall distortion is undesirable, because it affects the fine clearances existing between some movable components and their settings. These clearances are absolutely essential for the proper functioning of components like hinged or sliding doors, drawers and flaps. The existence of two different types of distortion, local and overall, leads to the possibility of separate investigations of the causes and effects associated with them. The difference between the local and the overall rigidity is illustrated in Figure 2. Here, diagram (*a*) shows an example of local distortion. The force does not alter the shape of the box as a whole but only

produces deformation in its own vicinity. In diagram (*b*) we can see an example of forces that produce purely overall distortion. Each of the five panels twist but none of them changes its rectangular shape into that of a parallelogram except for the open face which becomes diamond shaped with somewhat curved outlines. This mode of overall distortion can be obtained by other means as shown in diagram (*c*). The fact that different systems of forces produce the same mode of distortion is an inherent property of open boxes and is due to the high shear rigidity of the panels; or in other words to the high resistance of a rectangular panel to forces attempting to change its shape into that of a parallelogram.

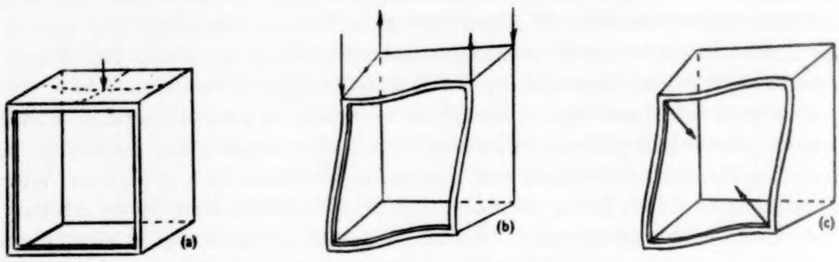

FIGURE 2. *Local and overall distortion*

As I have already said, the two rigidities can be dealt with separately. The local rigidity is a problem that can be solved piecemeal by experiment or by calculation of deformations of rails, stiles, panels, and shelves under various loads and finding the most advantageous construction. A far more interesting problem is the investigation on the overall rigidity, which will be dealt with in the following part of my paper. However, before trying to find the most economical rigid construction of cabinets, let us see if we cannot dodge the question, by dispensing with high overall rigidity. We shall now discuss three ways of doing it which deserve consideration.

The first is one that has been often suggested to me by people from the furniture trade. This method eliminates the effect of the unevenness of a floor by fitting an adjustable leg to a cabinet so that it can be levelled until the door and other movable components function properly. This is a possibility, but it has also certain disadvantages. It may be the right kind of solution for a large heavy wardrobe which is seldom moved, but I doubt if it would be acceptable for most smaller cabinets which require periodical moving for cleaning purposes.

The second way of dodging the question of overall rigidity is to mount the cabinet on three legs. Quite rightly it is thought that such a cabinet cannot distort because of an uneven floor. However, an uneven floor is not the only possible cause of distortion. Three-legged cabinets will be free from this particular cause but they have their own problems. They will distort whenever the distribution of their contents is unsymmetrical, or whenever the door is opened. Thus it seems that three-legged cabinets do not present a general solution to

the question of overall distortion of cabinets, though they may offer an advantage in the type of cabinet where unsymmetrical loading is unlikely.

The third way of getting over the distortion due to an unevenness of the floor is by using a deformable back in a cabinet. When a cabinet with a rigid back is set up on an uneven floor, then the whole unevenness has to be accommodated in the distortion of the front. If, however, both the front and the back are deformable then only part of the floor unevenness will be accommodated by the front, since the back will also be able to take up some of the unevenness. So that if the back is very much less stiff than the front, then it will take up most of the unevenness of the floor leaving the front comparatively undistorted, and it is the undistorted front which is necessary for the proper functioning of wardrobe doors. Here again, the remedy is limited to one type of cabinet only, namely, to those in which the movable components are fitted in the front frame, as for instance are hinged or sliding doors. Quite obviously the method would not be applicable to, say, a chest of drawers, because in this case the back as well as the front must be maintained undisturbed in order that the drawers may be moved in and out without jamming. There is more than one method of making a deformable back, but mention may be made of loose panel construction as a possible example.

So far we have dealt with means of avoiding rigid cabinets. As we have seen, the methods are not applicable to all types of cabinets, and even if we succeeded in removing the causes of distortion, such as the unevenness of the floor or unsymmetrical loading, we would still need some degree of rigidity. With the high cost of timber it will pay to achieve this degree of rigidity in the most economical way. Let us then examine a possible solution of the problem.

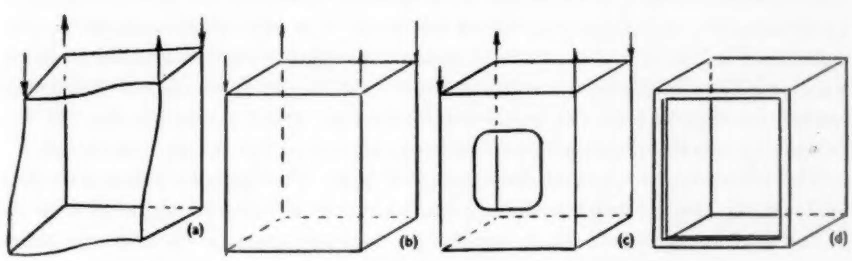

FIGURE 3. *Development of the front frame reinforcement*

Diagram (*a*) in Figure 3 shows a box distorted by twisting forces. We can see that each of the faces of the box twists and in addition the edges of the open face bend into S-shaped curves. The rigidity of such a box made from thin panels is comparatively low. If we try to increase its rigidity by increasing the panel thickness we will find that the material content of the box would have to be increased considerably to obtain the required degree of rigidity. Thus, this method must be regarded as uneconomical and we will have to look for an alternative method of increasing the rigidity of the box. The alternative can be

found if we realize that the lack of rigidity of the box we have just considered is due to the fact that one of its faces is completely open. You can verify this by experimenting with a biscuit tin with its lid on and off. A completely closed box, shown in 3 (*b*), is extremely rigid even if its panels are comparatively thin. The only disadvantage of this method of construction as applied to cabinet furniture is that you cannot put anything inside. We can overcome this difficulty by first cutting out a relatively small opening in one of the faces as shown in 3 (*c*). We will find that the box will still be quite rigid and at the same time we have gained access to the interior of the box. In most cabinet furniture this opening will not be regarded as large enough. To meet this objection we can increase the opening, compensating for the reduction in the width of the strip surrounding the open face by increasing its thickness. Thus we arrive at the construction shown in 3 (*d*) which is a five-sided box made up of thin panels with the sixth face replaced by a rectangular frame.

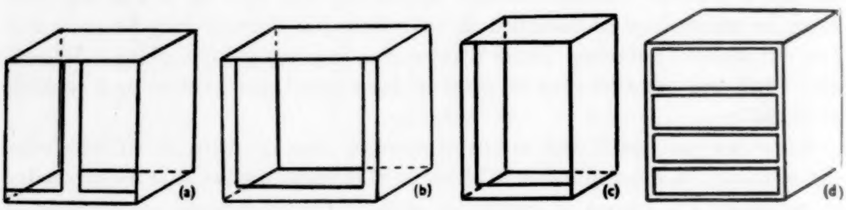

FIGURE 4. *Boxes stiffened by front frame reinforcements*

A rectangular frame is not the only possible method of reinforcing the open face. The inverted T construction in Figure 4(*a*) and the U reinforcement in 4 (*b*) are two other common constructions. The L reinforcement is not common but I have included it here because it suggests itself as another possible solution. The fourth construction, shown in 4 (*d*), used in chests of drawers cannot be regarded as a type of reinforcement, because the purpose of the horizontal rails dividing the open face is not structural but mainly functional.

The efficiency of material utilization has been investigated by mathematical analysis for the rectangular frame, the inverted T reinforcement as well as U and L reinforcements. First, assuming a constant material content and beam width, the optimum beam depth ratios were found for the members of the reinforcement. In this way we have obtained maximum rigidity from a given volume of material for each type of reinforcement. These optimum constructions of various reinforcements have in general different rigidities. A comparison of these rigidities in relation to a rectangular frame is given in Figure 5 for various proportions of the open face. We can see from it that the inverted T reinforcement is much more rigid than the rectangular frame for all proportions of the open face, whereas the U reinforcement is advantageous only when the horizontal side of the open face is larger than 1.4 of the vertical side, that is, when $\frac{h}{v}$ is larger than 1.4. The L reinforcement is as efficient as the rectangular frame for all proportions of the open face. I should like to point it out that these results

apply only to frame constructions with the reinforcement made from solid timber of rectangular cross-sections. An analysis of reinforcements made up from plywood and wooden beams would be somewhat more complex as it depends on many factors such as the relative elastic properties of the two materials, that is to say, wood and plywood, their dimensions and the type of construction.

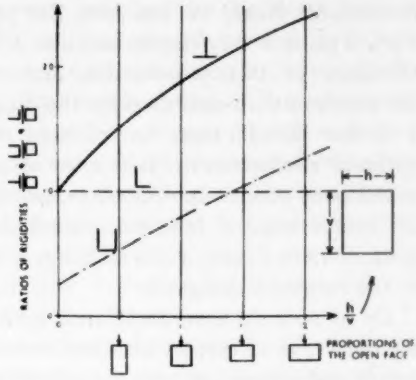

FIGURE 5. *Rigidities of various front reinforcements of optimum construction relative to the rigidity of a rectangular frame of the same material content. The members are of solid rectangular cross sections of the same width connected rigidly at the joints*

Let us now examine another way of reinforcing cabinet furniture. As I have already pointed out at the beginning of my paper, when a cabinet distorts all of its five panels twist. The angle of twist of each of the panels is in a fixed relationship to the twisting of the other panels and to the overall distortion of the cabinet. Thus we can see that the twisting of the panels cannot occur without the overall distortion of the box and *vice versa*. Consequently, we can prevent the box from distorting by making one of the panels infinitely rigid in torsion. This is shown in Figure 6(*a*), where a very rigid base prevents the box from distorting under twisting forces. This is a rather impracticable method. The nearest thing to this type of construction found in practice is a cabinet made from thick panels, although the method cannot be regarded as efficient. Perhaps a better way of doing it would be to replace the heavy base by a completely closed box, shown in 6 (*b*). As we already know, closed boxes are extremely rigid and so they provide very efficient stiffenings. The rigidity of such a box would depend to a large extent on the distance between the two large panels. I should like to point out at this stage that this type of stiffening does not have to be confined to the base of the cabinet. It can be fitted to its top or the end, whichever is the more

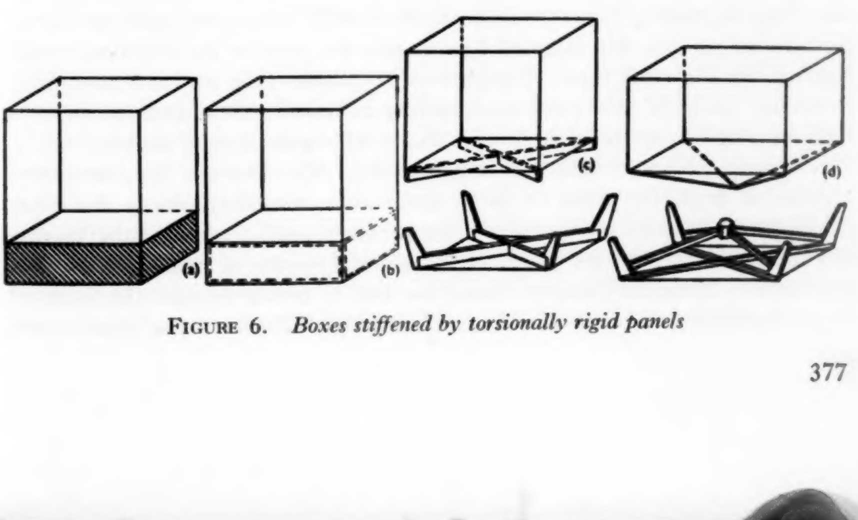

FIGURE 6. *Boxes stiffened by torsionally rigid panels*

convenient. Next, we can have the panel reinforced diagonally as shown in 6 (*c*). This is a very simple and also a fairly efficient method of stiffening. The efficiency of this construction increases considerably with the increase in the depth of the beam used for the diagonal reinforcement. Lastly, we consider a similar though more complicated structure in 6 (*d*), which we can call a pyramid reinforcement. It is more efficient than the previous construction but at the same time more difficult to manufacture and there may be some difficulty in incorporating it into the general design of the cabinet from the æsthetic point of view. I leave it as a challenge to the production engineers and a headache to the furniture designers.

Up to now we have considered cube-like cabinets. This, as we know, is not the only type of cabinet furniture in existence. There are cabinets with curved panels and occasionally one can see cabinets with sides having double curvature. What are the advantages of curved panels? Well, there is no great advantage in using curved panels as far as the overall rigidity of the cabinet is concerned because, as we have seen, a completely closed box with flat rectangular panels can be extremely rigid and the replacement of flat panels by curved ones will not alter its rigidity to any extent of practical significance. There is, however, a considerable advantage in using curved panels as far as local rigidity is concerned. This may be verified by comparing the deflection produced by pressing on the side of a cubical biscuit tin with the deflection that can be made on the side of a cylindrical tin of similar size. I am not suggesting that cabinets should be made cylindrical, because they might look rather awkward, but even panels of very much smaller curvature should be of considerable advantage in comparison with flat panels. The higher local rigidity permits the use of thinner panels which may result in substantial saving in material.

Since we have touched upon the subject of the shape of cabinets, I should also like to mention the question of the right cabinet shape and method of construction for the right type of material. There are quite a number of materials to-day available for the manufacture of cabinet furniture. They differ considerably in their elastic properties as well as strength. For instance, chipboard is produced in the form of thick panels of comparatively low strength and rigidity. If veneered with substantial structural veneers it becomes a sandwich panel having high resistance to local deformation. It can, therefore, be used to the best advantage in making frameless cabinets of cuboidal shape with perhaps a reinforced base of, say, the diagonal type to give the cabinet the required overall rigidity. On the other hand, thin plywood or panels made up from veneers by moulding would be used more economically as curved panels, because then the high local rigidity could be achieved with a small expenditure of material.

Returning to more orthodox constructions, Mr. Merrick has mentioned a practical problem, posed to us by a furniture manufacturer, to test these principles of cabinet construction. The problem was to increase the rigidity of a split wardrobe without increasing its material content or altering its external appearance. Since the original wardrobe had a centre pilaster the inverted T construction was chosen. The two moulded halves of the plinths and

their packing pieces, which previously were attached to the front rails of each half of the bottom, were incorporated into the inverted T structure as a single rigid unit, by linking them with a common beam and fitting in corner blocks at the joint between the two halves of the plinth and the pilaster. The ornamental piece at the top front rail was also attached firmly by gluing and screws, so that it was not allowed to hang loosely but was used as a structural element. In making these modifications the stress was on obtaining a rigid inverted T reinforcement, on which the rigidity of the wardrobe relied almost entirely. Particular attention was given to the areas at the joints between the pilaster, the plinth and top piece which are of utmost importance, since any distortion in these areas has a considerable effect on the overall rigidity of the structure.

The extra material necessary for these modifications was obtained by reducing the width of the top and bottom railing from $1\frac{3}{4}$ inches to $1\frac{1}{2}$ inches, and also by reducing the width of the packing pieces. Most of the modifications have been done to the construction of the plinth. Measurements of rigidity of the original and the modified wardrobe have shown that without affecting the external appearance, or the total material content, the modifications have nearly doubled the rigidity of the wardrobe. Although the improvement achieved in this example was quite satisfactory it can only be regarded as a stop-gap and there is little doubt that greater advantages can be gained if articles are designed from the start with these principles in mind rather than incorporating them as an afterthought in an already existing design.

The subject of the use of materials is wide and cannot be covered by a single paper of this kind. Little quantitative information based on systematic study was available up to now. It is our hope at the Research Department of the Furniture Development Council that our recent work will fill partly this vacuum of knowledge. A vacuum which cannot be afforded in this age of technological progress.

III. EFFECT OF THE RESEARCH ON THE CHARACTER OF CABINETS

by

ROBIN DAY, F.S.I.A.

For the designer and manufacturer, the importance of this scientific work done on cabinets is that it should do a great deal to take the guesswork out of cabinet construction. By trial and error, and the observation of other people's practices, most of us have arrived at forms of construction that have worked quite well, and intuitively we may already have known something of the aspects of rigidity clarified by Mr. Kotas. However, the problems have never before been fully analyzed so we have had no certain knowledge or data to work from. In the field of building, the architect and structural engineer have to hand the exact strength and behaviour characteristics of materials like steel and concrete,

and are able by the use of formulæ and calculations to know just what will happen when their buildings are assembled. No comparable information has been available to the furniture designer.

I am asked to say what effect on design the application of Mr. Kotas's principles will make. If we regard the economics of construction as a design consideration, and I think we must do so, we have to speculate on the value of the principles in reducing cost. It is obvious that their adoption would greatly reduce timber content by using material where it is doing its maximum work and eliminating it elsewhere. A great deal of timber could be saved, when compared to construction based on the usual empirical assessment of strength. On the other hand the sort of construction necessary to put some of the principles into use might involve a lot of machining and handling which could outweigh the saving of material. The principal of pyramid reinforcements might, if made in timber, be an example of this as it would involve many joints. In the case of the double and single curvature containers, these would entail initial investment in formers and special plant, but this could be offset by sufficiently large production.

But besides the economics of construction, the other very important design considerations are those of function and of æsthetics. In the design process, functional considerations should not be preceded by those of constructional method, because if a certain construction will make an article stronger or cheaper it will not necessarily make it more efficient in use, or better looking. But let us examine the application of the principles proposed in relation to what we know of the functional requirements of cabinets—that is, those pieces of furniture used for the storage of clothes, books, tableware, glass, gramophone records and all the other paraphernalia of the home. Such pieces of furniture are boxes opening at the front by means of doors (for observation and access in the vertical plane) and drawers (for access in the horizontal plane). I believe it is not possible to put forward a serious design without having thrashed out the full details of construction and I shall therefore give only the most tentative of sketches, merely to help us to consider one by one the various structural devices Mr. Kotas has described. It is one thing to make a sketch and a very different thing to get a model going smoothly through a production line, with all the problems connected with its manufacture solved. So I would like these ideas to be regarded as a basis for discussion rather than serious designs for furniture.

Now taking firstly the group 'reinforcements of the door opening':

1. *Plain rectangular frame.* This could be applied to a fairly orthodox looking cabinet, although a tendency for a heavy bordered appearance might be a disadvantage, and also the frame on the front bottom edge could hinder cleaning of the interior.

2. *Inverted T.* Again this principle could be used with a conventional looking cabinet. The plinth element would look rather unrelated and 'flapping in the breeze' unless the sides were taken down to its lower edge. To do this would, however, mean that a thin side would project downwards and easily fracture.

3. *U reinforcement.* This principle involves the use of two side pilasters. In the case of the drawer pieces this causes completely wasted interior volume, while with door fronted cabinets, the parts behind the pilasters are difficult of access. However, to avoid these snags the U frame could be on the outside of the box, which would produce an unorthodox though not uninteresting appearance.

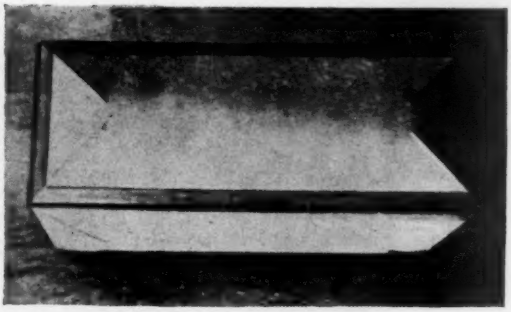

FIGURE 7. *Cabinet by Franco Albini; double curvature container*

4. *L reinforcement.* Some difficulty might be experienced in incorporating this principle into a balanced design, and it would be easiest to use where the design was very definitely asymmetrical in its other aspects besides that of the L member.

Double curvature containers: Full double curvature shapes such as spheres and ovoids are unsuitably shaped volumes for storage, but slight double curvatures of the planes of a rectangular cabinet could be moulded in plywood with high pressures. The results might be similar to that designed by Franco Albini of Italy, and shown in Figure 7. Strictly speaking, the panels of this cabinet are not made up of compound curves but a combination of curves in a single plane.

Single curvature containers: The beauty of this principle is that by use of special laminating plant, a continuous sheet of this ply can be made to form the back and sides of a cabinet (see Figure 8). The interior and also the back would be flush and unbroken by rails or blocks. Functionally the disadvantage of this approach, and a very serious one, is that curved interior volumes are the wrong shape for containing almost all the things one wishes to store, and also produce 'dead' or inaccessible areas in the same way that pilasters do. Aesthetically, too, the bulbous round shapes tend to be unpleasant, and in opposition to the crisp lines and clearly defined planes of the modern vernacular.

Using the principle of reinforcing the top or bottom of the cabinet against torsion by either a thick panel or closed box would not necessarily produce a radical change in the appearance of a conventional cabinet. The bottom of the cabinet could be constructed as a shallow box, perhaps becoming a plinth if the cabinet reached down to floor level. Where the piece is low and is to have a usable top surface such as a sideboard, the top could be a rigid panel perhaps supported direct from the ground with the box suspended below it. The principle of diagonally reinforcing panels could be used without being visually obvious by applying the reinforcements to the interior of the cabinet, or perhaps incorporated in the plinth or stand. It is difficult to see an obvious application of the pyramid reinforcement principle, but it might be possible to incorporate it in underframe construction.

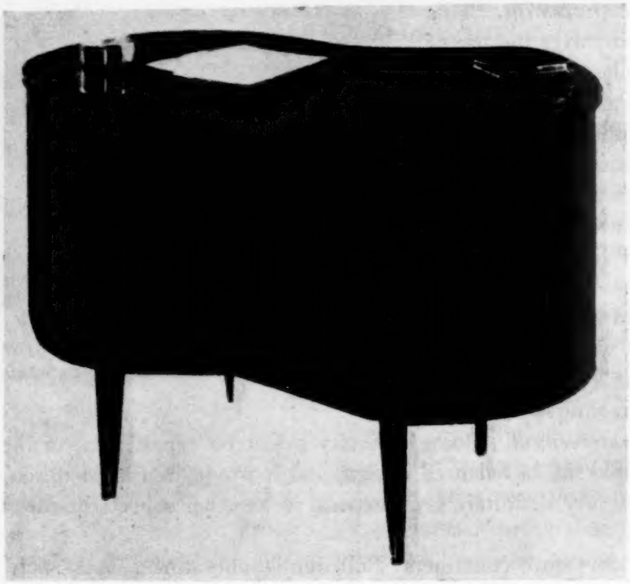

FIGURE 8. *Desk; single curvature container*

In industry the most popular of these principles outlined by Mr. Kotas would, I imagine, be those which could be exploited to reduce timber content without making much difference to the conventional appearance of furniture. However, their implications, especially if materials other than wood were embraced, could be much wider. The furniture industry has become fairly highly mechanized in the sense that it uses elaborate machines, but carries along with it many of the prejudices of its craft background and origins. Because of this, the most ingenious machinery has been developed to make quickly many of the joints which were invented for hand making. The design of furniture conceived for much more uninhibited machine production could derive much benefit from the kind of basic research we have heard about to-day. Not that these principles of obtaining rigidity will, on their own, unleash exciting new possibilities of design. However, the all too flimsy vocabulary with which the designer has to work is enlarged by them, and this kind of information, linked with further research on materials, methods of construction and the reassessment of function, could do much to advance the design of furniture.

DISCUSSION

MR. W. H. RUSSELL: In the design of a cross-braced stiffened structure it is obvious that the stiffness of the structure will be affected by the dimensions of the members used and also by the method of jointing the members where they cross. Has Mr. Kotas any information he could give us on this particular point?

MR. T. KOTAS: Yes, that is so. The cross-section will affect the rigidity of this reinforcement, as will also the method of jointing the two diagonal members in the middle. As far as the cross-sections are concerned, the larger the depth the higher

the rigidity. Regarding the method of joining these two members, in the simple structures which have been used in the experiments, each of the beams was halved at the crossover. This may not be a very good solution since the rigidity of the whole structure is not as great as it might be owing to the undercutting of each of the two members in the middle. We could, however, increase the rigidity of the joint by gluing blocks or reinforcing pieces at the intersection.

MR. D. L. MEDD: I speak in the capacity of a furniture designer and as representing the interests of the buyer and user of a particular group of furniture: school furniture.

I was interested in Mr. Merrick's point about the difficulty of defining with certainty the function or user requirements of furniture, which after all are the objectives to be satisfied by the designer. The designer cannot do his job properly unless the objectives are clearly stated. There seems, therefore, here an important aspect for definition by the Furniture Development Council. Take the common upright chair, for example. How many designers and makers have troubled to gather together the medical and postural data before putting pencil to paper? This is a job, among many of its kind, that wants doing centrally for the benefit of all, particularly as nowadays the customer is the anonymous public and not the enlightened individual as he was in the golden age of furniture making.

Another of Mr. Merrick's points that touched me was his reference to finishes. In the long run, the way to raise standards is to strengthen the arm of the customer. During a recent committee of standards for school furniture, the customer (for once) stated his requirements for the finish of table tops as precisely as current terminology would allow. But, in spite of trying, none of the several manufacturers represented could provide a specification, let alone define the term 'matt'. Meanwhile, the customer has to content himself with something shiny of unknown performance.

There must be a reason why Mr. Merrick did not mention one contribution that the Furniture Development Council, with others, has made which I consider of extreme importance: the development of the performance-test technique. This, apart from having an influence overseas, is the only means of specifying furniture standards which gives assurance to the customer and at the same time freedom to designer and manufacturer to employ whatever materials or techniques they consider suitable. This is a great step forward from the old method of specifying timber sizes and joint sizes and types, and so on, which was a perpetual clamp on progress.

Mr. Kotas' paper is of fascinating interest but after Mr. Day's paper, coming from a designer who has to produce an answer, I feel we are back where we started. Mr. Kotas said, 'I leave it as a challenge to the production engineers and a headache to the furniture designers'. In these days the furniture industry has plenty of headaches in its day-to-day work and is loth voluntarily to take on others. However, unless industry can prepare for to-morrow the outlook will indeed be gloomy. The discovery of new knowledge can only be useful if it is applied; research alone is not enough. 'Furniture Research Council' would seem to be a more appropriate title than Furniture Development Council, though I should like to see a combination of both. This implies that the research workers' team would take the first step in the application of the work. It could then be presented in a digestible and applicable form to industry; and, I believe, this is the only way to solve the difficulty remaining at the end of Mr. Merrick's paper: how to make research understood and useful. Otherwise there is the danger that research workers will begin to invent their own problems on which to work.

I speak with some experience of development work in the sense in which I have described and my remarks are made not as a criticism of the Furniture Development Council but as a plea for an extension of its activities, for I believe the marriage of research with development is the most powerful means any industry has of keeping in the lead.

Mr. Kotas gave us the optimum proportions of the beam cross section for the

various front reinforcements. Are there also optimum proportions for the reinforced panels of the pyramid type and closed-box type ?

MR. T. KOTAS: These two structures, the closed-box type and the pyramid, are mainly in the idea stage. We have not experimented with them to a great extent, and therefore cannot give any very definite data. However, from the preliminary mathematical analysis it seems that the closed-box structure increases its rigidity with the distance between the two horizontal panels. The further they are apart, the higher the rigidity. We have not investigated the pyramid construction, even by mathematical means, but there is probably a certain angle which, enclosed between the reinforcing rods and the panel gives a maximum efficiency, that is, rigidity per volume of material. At the moment we do not know what that angle is, and we do not know yet whether the angle which is best from the structural point of view would also be acceptable from the æsthetic view. Thus it may be necessary to make a compromise between these two requirements. If there is a demand for this structure in the industry, it may be decided that we should explore the structure further.

MR. M. J. MERRICK: I agree with what Mr. Medd said about development, and in my own view it is nearly always a more difficult, and certainly more expensive problem than carrying out the actual research.

It is very difficult to do development work without having at least what is usually called 'pilot plant' in other industries, and which we might call a miniature factory. We have not got a miniature factory, but there are a large number of factories in the industry, and it would probably be best if those interested in applying the results of Mr. Kotas' investigations, or any other of our work, were to contact us on a personal basis. In order to develop these results, without carrying out a long and expensive development programme beyond our resources, we must make contact with those manufacturers who are interested in applying them.

MR. CLAUDE E. GIBBS: We had the only example of timber economy in the reduction of the width of the top rail of a wardrobe. How did Mr. Kotas arrive at the reduction of the width, which I believe was a quarter of an inch and how did he establish that it was a quarter of an inch and not half an inch? Or was it a quarter of an inch less than he would have made it?

MR. T. KOTAS: These are the figures given to us by the manufacturer who said that originally he used $1\frac{3}{4}$ inches and later $1\frac{1}{2}$ inches. I am not saying that the material content was exactly balanced, but there was no appreciable change in material content. The manufacturer was quite satisfied with the amount of material he was using but he was not quite satisfied with the rigidity, and it was our job, in this instance, to find means of increasing that rigidity without using extra material.

MR. G. A. BRASTED: In view of what Mr. Merrick said, I wonder to what extent the type of approach exemplified by these three papers could be applied to the most economical construction of chair frames, a knotty problem?

MR. W. J. MERRICK: I agree with Mr. Brasted that it is a very knotty problem. There is little doubt, though, that the analytical, mathematical and experimental approach can be applied to chair frames, both of the upholstery-frame type and also of the dining-chair type. The reason that we tackled carcasses first was that we felt that, taking the industry as a whole, they showed the greatest potential saving. I hope that in the future we shall be able to apply similar methods to the design of chair frames and other items.

MR. ALAN HUNT: Could Mr. Kotas tell me whether these principles are suited only to conventioned material, or are they applicable to chipboard and other new materials?

MR. T. KOTAS: In our experimental work we have used exclusively plywood and solid wood, but as far as the methods of reinforcement are concerned the principles

stated are generally applicable, because the assumptions made in deriving them specify certain elastic properties rather than any particular material. There may, of course, be difficulties in joining chipboard, or troubles of a similar nature from other quarters.

MR. D. DAVIS: Can Mr. Merrick give any details of the principles through which he proposes to work on the measurement of seating pressures?

MR. M. J. MERRICK: Nobody ever likes to say how something works until they have made sure that it does work. At present this method is only in the design stage, but we are considering the use of a thin pad using a particular type of electrically conductive rubber. It is rather complex, and I would prefer not to go into details now, but the principle is that the electric resistance of the rubber changes with the pressure on it.

MR. JACK KAPE: I was extremely interested in these three papers; information should be made available to the schools and colleges. The rectangular reinforcement has been used for many years, I believe, in tea chests.

My first question concerns the pyramid structure reinforcement. On one of the sketches shown by Mr. Day he indicated his sub-structure which appeared to be a metal structure. Are these principles applicable to wood structure and not metal structure?

Could one of the speakers indicate the best way in which these principles could be applied by people who are not scientists?

MR. M. J. MERRICK: I should like to reply to the second question: how are these principles going to be applied by non-scientists? First, in the case of basic research, by trying to grasp the principles behind the results. This is where basic research is so valuable in an industry of our type in which, after all, there are very few scientists, since it does enable one to generalize to a certain extent. After a programme of research has been successfully carried out it enables one to ennunciate certain principles which can be gathered and applied by non-scientific people. Where applied research is concerned general application is more difficult, but for basic research much can be achieved by understanding the often simple principles which have arisen out of what may be very complicated research.

MR. T. KOTAS: I should like to answer the first part of Mr. Kape's question. The principles do apply also to metal and a structure of the pyramid type can be made from metal. I think it can be done best from metal because, with the latest developments in light engineering this type of structure can easily be fabricated by welding or some other engineering method.

We intend to produce a popular version of the report on our work. This report will be available to the industry and will explain in simple terms the research we have been doing on cabinet structures.

MR. L. J. GRIFFIN: The owner of a large factory producing many thousands of an article will put up very great resistance to a new method which would mean scrapping a lot of his machinery in order to carry it out, even if the product were afterwards made at half the former expense. Can it not be put over to the manufacturer very forcibly that he will get much benefit from this research?

Most of the benefits of the research are in the economy in material thickness with replacement of lost strength by other means. This is empirical development to the designer and rather obvious. It is fundamental research which is needed.

MR. M. J. MERRICK: There is most certainly a way in which a manufacturer can be persuaded: by good costing. If there is any doubt whether a particular principle is worth applying, then a good cost analysis will soon give the correct information.

MR. JOHN MORTON: Could Mr. Merrick tell us why rigidity was chosen as the problem to be investigated?

MR. M. J. MERRICK: Mr. Kotas gave some reasons why rigidity was chosen. In addition, it seems that rigidity is the main property to achieve which extra material is used. It seems that a certain degree of rigidity is a generally desirable characteristic, quite apart from the functional reasons that Mr. Kotas has mentioned.

MR. GEOFFREY DUNN: During the war some of our furniture factories made beautiful things, namely aeroplane parts and in some cases complete aircraft, especially gliders. I find it disappointing that no one has carried on the moulded plywood technique into carcase furniture. There are one or two notable exceptions in the making of chairs. In the middle and late 1930s some interesting furniture was made of laminated plywood, some models of which were made to flex and adjusted themselves to the unevenness of floors!

THE CHAIRMAN: We have listened with very great interest to these three papers, and have enjoyed hearing Mr. Merrick and Mr. Kotas explain to us their views on the questions they have had to treat.

Mr. Merrick gave us an outline of some of the work that has been going on in the Research Department, and told us of ways in which this work is to be extended. I feel sure that the results of this work will be of very great value to the industry, which will I hope increase the tempo of its growing interest in this subject of research.

I agree with Mr. Merrick that it is up to the industry to follow what is going on, and to be interested in this subject of research, although it is coming along well. It is up to them to increase that interest and then to see how far they can apply it in their own establishments. Mr. Kotas dealt with a most interesting question too. Some of us have realized that the appropriate introduction of a stiffening member would increase the rigidity of the carcase, but I doubt if many of us have realized that the appropriate introduction of a U or an inverted T section member will allow a reduction in the timber content which, of course, is tremendously important.

Mr. Robin Day considered some of the ways in which these principles can be applied in practice. We can arrive, in his view, at a really practical solution which will satisfy the artist, the manufacturer and also the consumer. Here we should remind ourselves of two very important considerations. Timber, plywood and veneers represent a very considerable part of the total cost of every kind of wooden furniture, and it is most important that the means by which they can be conserved should be found, not only in the interest of the public, but also in the interest of our international balance of payments, which should be very much present in our minds these days. Research is properly directed to finding the means and ways of solving these questions. Research, combined with research into work-study, method study and costings, and followed by technical training and education, can go a long way to developing our industry in a most advantageous and desirable manner. All these things are part of the work of the Furniture Development Council. It is most refreshing to listen to Mr. Merrick egging on the Furniture Development Council to do even more than it has undertaken to do up to this moment.

What Mr. Medd wants the Furniture Development Council to do is to some extent being done and is certainly very much in their minds. I hope that this is but the first of a series of meetings which will bring together all sides of our industry and also some of our critics. I feel that this is desirable. These talks can do much to improve our products and the industry; the homes of the people themselves should benefit.

I am sure you would want me to thank the lecturers for these most interesting papers, and also, as I do most willingly, to thank the Royal Society of Arts and the Furniture Development Council for so effectively collaborating in making this meeting this afternoon possible, so pleasant and instructive.

A vote of thanks to the Lecturers was carried with acclamation; and, another having been accorded to the Chairman, the meeting then ended.

THE FIRST EVENING DISCUSSION MEETING

RECENT DEVELOPMENTS IN CINEMA TECHNIQUE

The first evening discussion meeting of this Session was held in the Library of the Society's House on Wednesday, 1st February. The subject for discussion was introduced by Mr. Raymond Spottiswoode, and the meeting was presided over by Mr. Peter Le Neve Foster, a Treasurer of the Society.

In introducing the opening speaker, the chairman said that Mr. Spottiswoode had written a number of books on film technique and had worked on the technical side of films, both in this country and in Canada and the United States. During the Festival of Britain he had produced a number of three-dimensional films for the Television Cinema on the South Bank, and was at present working on the design of a new 3-D film camera for entertainment films and scientific research.

Mr. Spottiswoode said that the main points at issue were the technical and scientific developments that had altered the face of the cinema in the last four or five years. He would like, however, to dispel the idea—if it still existed—that the cinema industry was scientific or had any remote connection with a scientific frame of mind. He had spent many years in Hollywood and felt quite certain that technical developments came about in a very haphazard fashion as the result of discoveries that were made far outside the walls of Hollywood. Those developments, however, were viewed by the industry not as an industrial or a technological entity, but simply as a competitive branch of an entertainment medium which was finding itself in a worse and worse position in relation to other sources of entertainment, notably television. It appeared that the industry was in an extremely parlous condition and might have to close down, or convert wholly to television films, unless something were done to stimulate demand.

The first development to this end was Cinerama, in which a wide screen curved round to embrace the spectator, making use of peripheral vision to give a sort of 'engulfing' effect. Previously the great power of the cinema lay in its ability to present a picture from many different angles, to transport the spectator to and from a great many scenes in a few seconds. The image was quite small and could therefore be regarded as something separate from the spectator. In Cinerama, that scope was sacrificed in order to gain a picture so vast as to impel attention by sheer impact. A single shot took several minutes to unroll itself. This could be much more easily boring than the conventional film. Mr. Spottiswoode also mentioned the making of 3-D films, which gave the impression of depth and space and which, when combined with colour photography and stereophonic sound effects, gave a great sense of realism.

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part of the motion picture was also taking place. By the employment of stereophonic sound, an impression of sound in space was created, using a multiplicity of sound sources instead of the single one hitherto universal.

All these developments might be felt to have been evolved not with the object of increasing the artistic or expressive powers of the cinema, but simply with the object of stemming the attack by television on box-office receipts. The changes could be seen as having no set creative purpose other than to make the cinema larger and louder than it was before; to make it more aggressive and striking, with the result that its more intimate qualities were discounted. The continuation of the conventional films showed that the cinema still had great powers and possibilities, but it was decreed that it was not to continue so, and therefore those changes were instituted. The time would probably come, however, when the more interesting and creative possibilities of the new techniques would start to be explored: early glimmerings were to be found in the 3-D cartoons of Norman McLaren (1951), and the experiments in the 'dynamic frame' which had been sponsored by the British Film Institute and would be seen in a month or two.

In the discussion which followed, the history and present position of the wide screen and of 3-D films were traced. It was agreed that Vistavision was one of the more workable systems of the larger screens, that the close-up had become less important with the advent of Cinemascope, and that the tendency was to make more historical films in order to provide spectacular subjects.

As regards 3-D films, it was suggested that the work in this field had proved one of the biggest disasters in the film industry, because so much effort had resulted in so small an achievement. The main technical difficulty was double projection, but a new self-polarizing system was now being developed which would allow single projection, and it was possible that 3-D might return later on.

It was suggested that the design of the cinema should be altered to meet the new conditions, but it was pointed out that as the best viewing seats were necessarily greatly restricted, this would not be an economic proposition.

The question of audience response was raised and compared with that in the theatre, and with television.

The importance of the demand of television for films was also touched on. Many film companies might go bankrupt, it was suggested, if they were to lose their cinema interests, because the television film market could not make up financially the loss on cinema theatres. In fact, the production of films for television was becoming a separate technique.

Among those who took part in the discussion were Mr. John Crisford, Mr. Stanley Eker, Mr. L. Gibbes, Mr. T. S. Lyndon-Haynes and Mr. K. W. Luckhurst (Secretary).

GENERAL NOTES

SUNDOUR ANNIVERSARY

The fiftieth anniversary of the brand-name of Sundour, which occurred recently, is of considerable general interest, as its introduction by the firm of Morton in 1906 marked the first guarantee of colour-fastness in textiles. Morton's, who had for many years produced fine textiles, initiated in 1902 the research programme which led to the first range of colours fast to both light and water. This important piece of pioneering was followed by a second of equal significance, for when, in 1914, the outbreak of war cut off the supply of German dyestuffs used until then in the Sundour technique, the firm embarked on a further research project with a view to discovering the German secrets of producing these dyes themselves. This led to the establishment of a subsidiary company, now known as Standfast Dyers and Printers—and opened an entirely new chapter in the history of the British dyestuffs industry.

These achievements were described to the Royal Society of Arts in 1929 by the late Sir James Morton, to whose remarkable combination of vision, vigour and determination they were directly due, in a paper on 'The history and development of fast dyeing and dyes', for which he was awarded a Silver Medal of the Society. In 1925 he had been awarded the Faraday Centenary Medal, on the joint recommendation of the Royal Society, the Royal Institution and the Royal Society of Arts.

The developments in colour-fastness initiated in this way have led to the establishment of new standards throughout the British textile industry, and naturally to a resultant increased demand throughout the world for the products of the industry.

DOMESTIC HEATING CONFERENCE

The Institute of Fuel is to hold, on 1st and 2nd May, 1956, at Church House, Westminster, a Conference devoted to a special study of domestic heating in the United Kingdom. The projected Clean Air Act, slum clearance and housing programmes make this subject of great topical interest, and the Conference, in five sessions, will range over a wide field. The sections are divided under the following headings: Fuels; Appliances—their design and application; Design of dwellings; The planning and administration of smoke control areas, and a general discussion.

The Conference will be open without charge to the general public, but first call on the available seating will go to persons enrolled as Conference members. Enrolment is free to Members of the Institute of Fuel; at a fee of 10*s.* 6*d.* to members of participating bodies; and of £1 1*s.* each to others. Enrolment forms and full particulars are obtainable from The Secretary, The Institute of Fuel, 18 Devonshire Street, London, W.1.

JAPANESE PORCELAIN EXHIBITION

An Exhibition of Japanese Porcelain, arranged by the Oriental Ceramic Society in co-operation with the Arts Council of Great Britain, is at present on view at the Arts Council Gallery, St. James's Square, where it will remain until 28th April. The Exhibition concentrates mainly on the earlier period of porcelain manufacture in Japan, that is from the first half of the seventeenth century until the end of the eighteenth century.

The Exhibition is open on Mondays, Wednesdays, Fridays and Saturdays from 10 a.m. to 6 p.m., and on Tuesdays and Thursdays from 10 a.m. to 8 p.m. Admission 1*s.*

OBITUARY

SIR ALEXANDER MURRAY

We record with regret the death, in Buckinghamshire on 19th March, of Sir Alexander Murray, K.C.I.E., C.B.E., at the age of 83.

Alexander Robertson Murray started his career as an accountant in Calcutta, and became successively head of two large firms. Twice chairman of the Indian Jute Mills Association, and president for a year of the Indian Mining Association, he did much to promote the two industries. At one time president of the Bengal Chamber of Commerce, he represented that body in the Bengal Legislature, the Imperial Legislative Council and the Council of State. He later was president of the Associated Chambers of Commerce of India, and its representative, in 1927, in the Indian Legislative Assembly.

He served on various committees concerned with currency problems, and was a governor of the Imperial Bank of India. He twice represented employers in India at International Labour Conferences, and served on the Royal Commission on Indian labour, 1929–31, being deeply interested in questions of the treatment of labour staffs. He was also on a number of boards in this country, and was a deputy governor of the Hudson's Bay Company. He was made C.B.E. in 1916, knighted in 1921, and created K.C.I.E. in 1936.

Sir Alexander was a member of the former Indian Section Committee of the Society and then of the Commonwealth Section Committee, on which he served until his death. In 1934 he read a paper on 'The jute industry' at a meeting of the Indian Section, for which he was awarded a Silver Medal. In 1949 he took the chair at a meeting of the then India, Pakistan and Burma Section, when Mr. W. A. M. Walker read a paper on 'The growth of the jute industry in India and Pakistan', and he also took part in discussions at other meetings of the Society.

He was elected a Fellow of the Society in 1918.

NOTES ON BOOKS

ROBERT MYLNE, ARCHITECT AND ENGINEER, 1733 TO 1811. *By A. E. Richardson, Batsford,* 1955. 30*s*

To-day we regard Art and Science as separate and quite dissimilar things. This attitude, clearly a manifestation of the schism that has grown between art and science, architecture and engineering, is relatively new and a particular phenomenon of modern social culture. Robert Mylne was one of the last of the 'whole men' of the Renaissance in Britain, in whose work can be seen the best of engineering thought and method of his times, as well as some considerable expressions of art. Professor Sir Albert Richardson, than whom there is no one more learned on the subject of eighteenth-century architecture, brings this out in an admirable book necessary to the bookshelves of all who would study a period which produced a style in architecture and the allied arts the character of which in high quality and uniformity has not again been seen. Not many years after the death of Mylne the unity of style exhibited in eighteenth-century art broke up, as did the social framework of which the art was a significant part and this was an outcome of the great and rapid changes in the social cultural configuration of Western people. If we do not like the outcome we make a scapegoat of the Industrial Revolution, popular symbol of the changes wrought by science allied to capital. However, as well as in science and technology it is in architecture and engineering, in men like Robert Mylne, in their production of practical, down-to-earth buildings, bridges and other works fit for specific purposes and fulfilling social requirements of the time, that we see the beginnings of the technological changes that were soon to shake the world. Although Mylne's structures express, in their ordered classicism, the eighteenth-century concept of life ruled by deterministic laws, it is clear from the evidence in Sir Albert Richardson's book, particularly in the Diary, that Mylne's activities were manifold and his energy tremendous. Nothing was too much trouble and in his building, water works and bridges, he sought the best technical solutions to the problems arising. Like a good Scot he was a sound business man who was 'extremely exact and checked all his

concerns with great care'. One feels that if Mylne had been born somewhat later, into the Ruskin era, he might have been a great nineteenth-century engineer and if later still, into our times, a modern architect, who would find modern disciplines, those imposed by complex present-day requirements and engendered by the use of modern materials, greatly suited to his temperament and a challenge to his restless nature.

In the very interesting Introduction, Sir Albert Richardson writes: 'Architecture is a progressive art and does not favour an exact repetition of historical forms. On the other hand, it does admit a return to first principles'. Most would agree with these dicta, but many would say that to-day there is no justification for the repetition of any historical form once a return to a great and universal principle of architecture, namely the structural, is admitted. This is because there has been such a profound and revolutionary technical change since the eighteenth century: the concept of the masonry arch and dome and the load-bearing wall has given way to that of the steel and reinforced-concrete frame, and no appeal for academicism, no plea for a return to the past, can alter this fact nor can it lessen man's infinite capacity for expression in the new structural forms and materials nor restrict his departures in his never-ending search for new ideals of beauty. Sir Albert Richardson may not agree with this but the view point is implicit in his own most distinguished Introduction to Robert Mylne's Diary.

BASIL WARD

BIRD LIFE AND THE PAINTER. *By R. B. Talbot Kelly. Studio,* 1955. 30*s*

With the spate of bird books now appearing, which are illustrated by photographs, one by a painter is at least very refreshing. In his opening chapter Mr. Talbot Kelly defines what, in his opinion, constitutes good and bad art.

When the author starts on bird painting, it is made obvious that he has been largely impressed by the work of the Egyptian artists, their presentation of birds being more impressionistic than realistic. He feels, and feels it strongly, that the modern world has lost the simplicity of soul which the Ancients had in great measure. This loss lessens the 'seeing mind', as the author terms it, to a very great degree, and thus the 'dignity of birds' is very often missing in the painting of the modern artists.

The author shows an interesting contrast between the work of the Egyptian and Chinese artists. The work of the latter could be best described as contemplative, whereas that of the Egyptians is more active in its execution. He finds that the Egyptians showed the 'essence' of a bird, however stylized its depiction. The Chinese had this gift also, but added to it the moods of nature as affecting the birds, for example, wind-tossed birds with their feathers draggled or frayed, but always the background is the perfect complement for the birds painted.

The further chapters, interesting in themselves, are more in the nature of a bird-lover's and painter's autobiography. Much can be learnt from them on this most difficult form of the art of painting. As the author very truly says, birds will not 'sit' for their portraits, and the artist must cultivate a tremendous visual memory and the ability to make quick notes, perhaps of a claw, a head or a wing. The author makes it clear that the would-be bird artist must realize that a bird is a living, sentient being, not a stuffed specimen in a museum. A bird is peculiarly full of life and grace, both of which are entirely lacking in a stuffed bird, though, as the author points out with a telling illustration, a newly dead bird has still some of that most elusive charm, which adds so much to the enjoyment derived from watching birds.

In the author's delightful drawings and paintings there is a distinct suggestion of Chinese influence in the muted tones and general arrangement of his 'subjects'. Is there also a slight hint of nostalgia for all the beauty poured out so lavishly by Nature, and uncaptureable with paint and pencil? In short, the author does prove

that, to paint birds well, it must be remembered that they are first and foremost, as he has stated several times, living creatures, and not merely ornamental shapes.

The illustrations are all delightful in themselves and their reproduction is of that high quality one expects in a Studio publication.

W.P.C.T.

FROM THE JOURNAL OF 1856

VOLUME IV. *21st March*, 1856

A LECTURE ON LOVE

From Proceedings of Institutions

DEPTFORD.—A lecture on 'Love' was delivered at the Literary and Mechanics' Institution, by Mr. E. J. Reed, one of the editors of the *London Mechanics' Magazine*, to a numerous audience, on Wednesday evening, 12th March. The subject, of delicate interest to all, was eloquently and philosophically discoursed upon by the lecturer, who also read, with much taste and effect, several of the best pieces on the subject from Tennyson, Coleridge, Bailey, and others. The reading of a long scene from Bailey's 'Festus' was the only point in the whole of the Lecture which failed in giving entire satisfaction to all present. The lecture was full of beautiful similes, and poetical descriptions; and the members hope, ere long, to enjoy a similar treat from the same gentleman.

Some Activities of Other Societies and Organizations

MEETINGS

WED. 4 APR. Electrical Engineers, Institution of, Savoy Place, W.C.2. 6.15 p.m. *The B.B.C. Television Station of Crystal Palace.*

Fuel, Institute of, at the Institution of Civil Engineers, Great George Street, S.W.1. 5.30 p.m. L. Clegg: *Fuel and Power Surveys.*

THURS. 5 APR. Radio Engineers, British Institution of, at the College of Technology, Sackville Street, Manchester. 6.30 p.m. D. R. Coleman and D. Allanson: *Design of an Underwater Television Camera.*

FRI. 6 APR. Mechanical Engineers, Institution of, 1 Birdcage Walk, S.W.1. 5.30 p.m. G. B. R. Feilden, J. D. Thorn and M. J. Kemper: *A Standard Gas Turbine to Burn a Variety of Fuels.*

Radio Engineers, British Institution of, at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1. 6.30 p.m. Discussion opened by R. H. Garner: *The Importance of Visual Aids in the Teaching of Advanced Radio and Electronic Engineering.*

SAT. 7 APR. British Interplanetary Society, at Caxton Hall, Caxton Street, S.W.1. 6 p.m. J. Foley, E. White and R. Wilkins: *Power Supplies and Telemetry for Instrument-Carrying Artificial Satellites.*

MON. 9 APR. Engineers, Society of, at the Geological Society, Burlington House, W.1. 5.30 p.m. F. G. Laming: *Technical Developments in Laying Gas Mains.*

TUES. 10 APR. Analytical Chemistry, Society for, at the Imperial College of Science and Technology, South Kensington, S.W.7. 6.30 p.m. (1) B. W. Bradford: *Progress in Plant Analytical Control Methods,* (2) A. E. Martin: *The Sonic Gas Analyser,* (3) D. A. Patient: *Automation in the Laboratory.*

Chemical Engineers, Institution of, at the Geological Society, Burlington House, W.1. 5.30 p.m. H. I. Downes: *Patents in Chemical Engineering.*

Illuminating Engineering Society, at the Gaumont-British Theatre, Film House, 142 Wardour Street, W.1. 6 p.m. L. Knopp, S. T. Henderson and R. D. Nixon: *Symposium on Screen Viewing.*

Incorporated Plant Engineers, at the Royal Society of Arts, W.C.2. 7 p.m. H. Westwood: *Electrical Industrial Repairs.*

Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, 3. 6.30 p.m. W. R. Butler Jones: *Parts of New Zealand.*

Textile Institute, at the Bolton Technical College, Bolton. 7.30 p.m. C. S. Whewell: *Where Do We Stand?—New Fibres and Finishes.*

WED. 11 APR. Archæological Institute of Great Britain and Ireland, Royal, at the Society of Antiquaries of London, Burlington House, W.1. 5 p.m. M. W. Barley: *Documentary Evidence for Housing Improvement in the 16th and 17th Centuries.*

Locomotive Engineers, Institution of, at the Institution of Mechanical Engineers, 1 Birdcage Walk, S.W.1. 5.30 p.m. J. M. Doherty: *Evolution of the Internal Combustion Locomotive.*

Meteorological Society, Royal, 49 Cromwell Road, S.W.7. 5 p.m. J. Paton: *The Polar Aurora.*

Petroleum, Institute of, 26 Portland Place, W.1. 5.30 p.m. J. W. Platt: *The Oil Industry—its Place in the World and its Future.*

FRI. 13 APR. Engineers, Junior Institution of, Pepys House, 14 Rochester Row, S.W.1. 7 p.m. P. A. Frowley: *Steam Turbine Principles and the Characteristics of the Various Types.*

Mechanical Engineers, Institution of, 1 Birdcage Walk, S.W.1. 5.30 p.m. (1) Professor J. L. M. Morrison, B. Crossland and J. S. C. Parry: *Fatigue Under Triaxial Stress: Development of a Testing Machine, and Preliminary Results,* (2) N. E. Frost and C. E. Phillips: *The Fatigue Strength of Specimens Containing Cracks.*

Metals, Institute of, at the Institution of Naval Architects, 10 Upper Belgrave Street, S.W.1. 2.30 p.m. Dr. Erich Schmid: *Electron Emission from Metals.*

OTHER ACTIVITIES

NOW UNTIL 7 APR. Contemporary Arts, Institute of, 17-18 Dover Street, W.1. Memorial Exhibition: *Willi Baumeister.*

WED. 11 APR. The Building Centre, 26 Store Street, W.C.1. 12.45 p.m. Film Show: *It's an Ill Wind (the manufacture and use of paint).*

LIBRARY ADDITIONS

CRAFTS AND LIGHT MANUFACTURES

BERRY-HILL, HENRY *and* BERRY-HILL, SIDNEY. Antique gold boxes, their lore and their lure. *New York, Abelard press*, 1953. Presented by Henry Hill.

THE BRITISH SOCIETY OF MASTER GLASS-PAINTERS. A directory of stained glass windows within the past twenty years. *London, British society of master glass-painters*, 1955. Presented by the author.

BUSHNELL, GEOFFREY HEXT SUTHERLAND *and* DIGBY, ADRIAN. Ancient American pottery. *London, Faber*, 1955.

CHARLESTON, ROBJERT JESSE. Roman pottery. *London, Faber*, 1955.

EYLES, DESMOND. 'Good Sir Toby': the story of Toby jugs and character jugs through the ages. *London, Doulton; Leigh-on-Sea (Essex), F. Lewis*, 1955.

GARNER, *Sir* HARRY MASON. Oriental blue and white. *London, Faber*, 1954.

HENDLEY, THOMAS HOLBEIN. Persian and Indian bookbinding; [in] The journal of Indian art and industry, [n.d.].

HOLLAND. Royal coin cabinet. Penningen: medals. The Hague, Royal coin cabinet, [1953].

JACKSON, F. HAMILTON. Intarsia and marquetry. *London, Sands and Company*, 1903.

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